EVALUATING INTERNATIONAL PROJECTS:
WEIGHTED-AVERAGE COST OF CAPITAL VERSUS
VALUATION BY COMPONENTS

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ABSTRACT

The adjusted net present value approach to international capital budgeting has been questioned recently as to its theoretical correctness and ease of applicability. The alternative set forth by critics is a return to the weighted average cost of capital. In this paper we compare these two approaches, show the conceptual superiority of adjusted net present value to weighted average cost of capital (indeed the latter is a restrictive special case of the former), and reaffirm the usefulness of valuation by components in the international corporate setting. In particular, we illustrate its application to projects involving blocked funds, concessional finance, cash flows with differing exposures to nominal and real exchange rate movements, and political risks that depend on project cash flows as well as to sensitivity analysis in general.

1. INTRODUCTION

In two recent papers, Lessard [6,8] advocates the use of an adjusted present value or valuation by components approach in evaluating international projects. The primary advantages he identifies are that the valuation by components rule (VCR) is simpler and more transparent than the more familar weighted-average cost of capital (WACC) approach, given the complexities inherent in most international projects. These complexities include the ability of an international firm to arbitrage segregated capital markets and existing tax systems through the various funds' flow channels available (see, e.g., Lessard [7]). Further, VCR allows for explicit treatment of non-zero net present value (NPV) financial interactions, and provides for separation of nominal and real components of cash flows. Booth [1] argues that this simplicity is illusory and that the VCR approach is an approximate solution that may be substantially in error in certain cases. He claims that only the WACC method of calculating NPV is consistently correct, and that the firm's optimal debt capacity must be derived by the WACC methodology before the VCR approach can be implemented.

Booth's comments are directed at the VCR approach in general and address none of the factors that distinguish international from domestic capital budgeting as identified by Stonehill and Nathanson [19], Rodriguez and Carter [13], Shapiro [16], Lessard [6,8], and Folks [3], among others. Nevertheless, since Booth calls into question the validity of the VCR approach, which we believe has significant advantages in the international case, we feel that it is important to respond to his concerns here. First we address the conceptual issues raised by Booth;

then we discuss the practical implications of that analysis for international capital budgeting decisions.

Capital budgeting analysis is the valuation of uncertain future cash flows. Both the nature of the risks these flows are exposed to and the structure of their payoffs must be addressed. A convenient analytic characterization of these flows is by fundamental type:

1. equity equivalent
2. debt equivalent
3. option (contingent claim) equivalent

Most projects are comprised of all three types of flows. Therefore no simple rule such as WACC is likely to work. While an elaboration of these types is beyond the scope of this paper, the VCR methodology allows additive valuation of the various types of components flows by the respective valuation technique most appropriate to its fundamental character.

In the sections that follow, we review the relationship between the WACC and VCR approaches, and restate some of the reasons why we believe VCR is more convenient in evaluating international projects. Drawing on the VCR approach developed by Myers [11], which he terms adjusted present value (APV), we show that the VCR method is the general case and is the correct valuation mechanism in all situations. We show that WACC is a special case of VCR and that Booth's numerical examples, which purport to show the opposite, are incorrectly applied.

In particular, given the Modigliani-Miller (MM) world which Booth assumes, the two approaches are theoretically equivalent. However, the VCR approach is the general solution whereas the WACC approach is the

approximation that is correct only under the conditions assumed by MM. To illustrate why the VCR approach is a more convenient method for a large class of international situations, we provide explicit examples of the complexities that arise when the WACC approach is employed.

2. WACC VS VCR APPROACHES

As a result of the "cost of capital revolution" in the 1960s, the dominant approach to project evaluation is to discount expected after-tax project cash flows by a weighted-average cost of capital in the following "net present value" formulation:

$$NPV = \sum_{t=0}^{T} \frac{\overline{CF}_t}{(1 + K_a)^t} \tag{1}$$

where NPV is net present value, $\overline{CF}_t$ is the expected after-tax (including the tax effects of depreciation deductions but not interest deductions) project operating cash flow in period t, and K_a is the weighted average cost of capital. K_a in turn is usually defined as:

$$K_a = K_e \frac{S}{V} + K_d(1 - t_c) \frac{D}{V} \tag{2}$$

where D/V and S/V are the (market) weights of debt and equity respectively (S + D = V), K_d is the pretax interest rate on debt, t_c is the corporate tax rate, and K_e is the required rate of return on levered equity. Equation (2) is generally referred to as the traditional "textbook" formulation. (See the Appendix for a glossary of notation.)

The advantage of this traditional approach is its simplicity. It imbeds in a single discount rate all financing considerations, thus

enabling planners to focus on the project's overall investment characteristics. However, different discount rates are required for projects that differ from a firm's typical project in terms of either business risk or contribution to debt capacity, and equation (2) provides little guidance since K_e will be changed by an unspecified amount.

Differences in project debt capacity can be incorporated via the alternative weighted-average formula developed by Modigliani and Miller:

$$K_a = K_u(1 - t_c \frac{D}{V}) \tag{3}$$

where K_u is the "all-equity" or unlevered required rate of return on the project's assets reflecting the project's business risk. Further, since K_u can be project specific, equation (3) can be generalized to situations where business risk differs as well. Using the Capital Asset Pricing Model (CAPM) to determine K_u in equation (3), the project required rate of return, K_{aj}, is given by:

$$K_{aj} = [r + \beta_j(K_m - r)]\ [1 - t_c \frac{D}{V}] \tag{4}$$

where β_j is the project's equity beta coefficient (adjusted to remove the effect of leverage), K_m is the required return on the market portfolio, and r is the riskless rate of interest.

Thus NPV using WACC combines all operating cash flows adjusted for income taxes, including depreciation tax shields but not interest tax shields, in the numerator CF_t in (1) and discounts these by one rate, K_a (or K_{aj}), which has been adjusted in an attempt to reflect business risk, debt capacity, and the tax effects of financial structure. Equation (1) yields the NPV estimate of the levered project.

APV as presented in Myers [11], on the other hand, goes beyond

NPV/WACC by expressing the NPV of the levered project as the sum of the two components--the NPV of the unlevered project's operating cash flows and the NPV of the tax shields from debt. These respective NPVs are discounted at rates reflecting the risk of each--K_u for the operating cash flows and K_d for debt. We may write this simple form of APV as in equation (5):

$$APV = \underbrace{\sum_{t=0}^{T} \frac{\overline{CF_t}}{(1+K_u)^t}}_{\text{(NPV of unlevered operating cash flows)}} + \underbrace{\sum_{t=0}^{H} \frac{K_d D t_c}{(1+K_d)^t}}_{\text{(NPV of tax shields on debt)}} \qquad (5)$$

Thus, this valuation by components rule deals with the problems created by differences among projects in operating risks, debt capacity, and taxes in a direct manner. First, all cash flows are separated into a number of components determined by their differing risk characteristics. For example, revenues and costs may be broken out of operating cash flows. These component flows then are discounted at rates reflective of their own particular risk elements. These discount rates do not incorporate the debt and other financing impacts, since these financing factors, including debt capacity differences, are dealt with as a separate set of cash flows in VCR. Thus adjustments to K_e and K_u for the effects of leverage or taxes as shown in equations (2), (3) and (4) are avoided.

Second, in the VCR method all these sets of discounted cash flows, from investment and financing aspects separately, simply can be added together to determine the project's APV.

As shown by Myers [11], the weighted average cost of capital is a correct criterion for capital budgeting decisions only under restrictive circumstances. In particular, he shows that WACC is a special case of the more general valuation by components rule. How closely this special case matches the correct general VCR formulation depends on the specific WACC formulation used; the two most commonly used versions are the Modigliani-Miller (MM) and "textbook" or "cocktail formula" definitions discussed above. We will not duplicate Myers' in-depth analysis here; rather, we will outline the assumptions and essential points of the arguments and indicate the concommitant problems with Booth's presentation.[1]

In a world of certainty and no imperfections (e.g., taxes or transactions costs), there is no theroetical distinction between WACC and VCR. This is because all financial claims earn the riskless rate and tax-deductibility[2] is meaningless. In this unrealistic world both methods yield correct and identical capital budgeting decisions. If taxes exist and interest is deductible, but the world remains certain, then only debt is issued and again VCR and WACC[3] are equivalent.

However, in the realistic case where a hierarchy of risky financial claims exists, as with corporate debt and equity, and interest is

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[1]For further, more recent discussion of VCR vs WACC, see Myers [12].

[2]For simplicity of exposition in the remainder of this section we will consider tax-deductible interest on debt as the only important imperfection. For a discussion of the role of transactions costs, agency costs, and the like the reader is referred to Jensen and Meckling [5]. For a discussion of the particular imperfections occurring in international finance see Lessard [8]. We also can ignore the role of dividends without loss of generality.

[3]This result can be shown to hold whether the MM or textbook formulation is considered.

tax-deductible, the credibilities of VCR and WACC measures[4] begin to diverge. In particular, Myers clearly shows that VCR is correct while WACC gives a biased measure[5] of a project's true NPV if either of the following conditions[6] exist.

I. The project's cash flows are of finite life.

II. The project does not make a constant and permanent (i.e., in perpetuity) contribution to the firm's debt capacity.

Only if the project generates a perpetual cash flow stream and contributes a perpetual constant amount of additional debt capacity to the firm are VCR and WACC equivalent theoretically. However, the WACC is correct only as this special case of VCR.

Alleged Drawbacks of VCR

Practical capital budgeting situations, particularly in the international arena, are characterized by both these conditions. Thus VCR is the correct general theoretical rule to follow in decision analysis. Lessard [6,8] shows how VCR can be applied fruitfully

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[4]As Myers [11] clearly shows (see, for example, his discusson on page 11) the correct use of the "textbook" formula is based on much more restrictive assumptions than his "generalized MM" formulation of WACC. Thus we consider only the latter in the remainder of our discussions here. Booth [1] does not explicitly recognize these important distinctions (e.g., the characteristics of the firm's existing risky assets and financing mix). He assumes an MM world and uses the "textbook" formula as an implicit special case of MM in his comparison.

[5]Use of WACC as a hurdle rate likewise yields a biased result if any of these conditions hold.

[6]Also implicit in Booth's analysis is that "value-additivity," as defined by Myers [10] and, later, Schall [15], holds. We continue with that assumption here. Thus risk independence and causal independence hold and their implications for shifts in the firm's risk characterstics and target debt ratio are excluded from this list.

to encompass the many complexities of an international project. But what of Booth's contentions that a simple NPV using WACC must be calculated before VCR can be measured because VCR requires the project's debt capacity, and that application of VCR is far more complicated than this NPV approach in any event. We now address those two contentions in turn.

Booth assumes away both the two key conditions listed above. He assumes a constant, perpetual cash flow from operations (see p. 3 in Booth [1]) which obviates condition I. Next he implicitly assumes a constant and permanent contribution to debt capacity by the new project. (This assumption is illustrated by equations (2), (4) and (7) in Booth [1]--see pp. 3, 6 and 7.) Thus Booth has implicitly assumed a model in which VCR and WACC are equivalent. Thus his "proof," supported by his numerical comparison of the techniques (as summarized in his Table 2 with calculations presented in his Table 3) is invalid--we will show momentarily why his numerical results in Table 3 for these two equivalent methods differ. Also, both VCR and NPV using WACC require knowledge of the project's debt capacity in order to calculate the interest tax shields and the weights in WACC. (Myers clearly shows the need to use market rather than book values for debt and equity.) Booth's statement (on p. 11) that NPV must be derived first using WACC before VCR can be calculated since this NPV determines debt capacity is incorrect as shown below. The key point is that the same exogenous information is needed to determine debt capacity for both the WACC and VCR methods. In both methods project debt capacity is a function of market values. However, the WACC assumption of constant market value weights is probably not realistic.

In most of his paper, Booth claims that optimal debt capacity is determined endogenously in the WACC calculation, but must be specified

exogenously (or first derived from the WACC calculation) for the VCR method to be correct. Yet, in his "proof" he incorporates an exogenously-specified interest coverage constraint into WACC to determine debt capacity which is a contradiction of his earlier assumption. With this assumption, it is readily shown that WACC is incorrect while VCR is correct. Thus Booth's claim that VCR is more complicated to implement than WACC due to the difficulty in measuring debt capacity is erroneous.

The assumptions about and treatment of debt capacity are of critical importance at both conceptual and practical levels in capital budgeting analysis. Yet there is no simple rule for specifying project debt capacity. Thus these assumptions must be made clear because they determine the correctness of the evaluative methodology, e.g., as discussed above for Booth's application of WACC. The basic assumptions concerning debt capacity are whether it is endogenous or exogenous to the project, and whether it is perpetual or of a finite life. For example, the tax shields on debt are assets which endogenously induce more debt capacity depending on the nature of the project and riskiness of the tax shields[7].

Table 1 illustrates these assumptions. Box I (endogenous and of finite life) is the most realistic set of assumptions, but analytically the most difficult. Box IV is both the simplest and most restrictive set, and also is required for WACC. Applications of VCR generally assume exogenous debt capacity determination but handle any maturity with ease; thus VCR holds for either Box II or IV. Booth's WACC is in Box IV.

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[7] See Ruback [14] for a discussion of the effects of riskless tax shields in this context.

Table 1

Debt Capacity Assumptions

		Determination	
		Endogenous	Exogenous
Maturity	Finite-Lived	I	II
	Perpetual	III	IV

Booth's Examples

Consider first Booth's world, case IV, without the interest rate subsidy. Following his notation we can write equation (1a) for the NPV using WACC and (2a) for VCR (i.e., Myers' APV).

Without Interest Subsidy (i.e, $K_d = K_{d1} = K_{d2}$)

(1a) $$\text{NPV:WACC} = \frac{\bar{\pi}(1-t_c)}{K_a} \qquad \text{where } K_a = K_e \frac{S^*}{V} + K_d(1-t_c)\frac{D^*}{V}$$

$$\text{and where } K_e = K_o + (1-t_c)(K_o - K_d)\frac{D^*}{S}$$

(2a) $$\text{APV} = \frac{\bar{\pi}(1-t_c)}{K_o} + D^{**}t_c \quad \text{where } D^{**} = \frac{D^*}{V} \cdot \text{APV}$$

where, from Booth's notation, $\bar{\pi} = \overline{CF}$, $K_{d1} = K_d$, K_{d2} = subsidized interest rate on debt, $K_o = K_u$, D^* = optimal debt amount under NPV:WACC, and D^{**} = optimal debt amount under APV.

Using Booth's example[8] of $t_c = .5$, $I = 1{,}000{,}000$, $K_o = .18$, $\frac{D^*}{V} = \frac{S^*}{V} = .5$, and $K_d = .15$ we can substitute into equations (1a) and (2a) to calculate the following results shown in Table 2 for his different values of $\bar{\pi}$.

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[8] We will not deal with the question of why Booth uses the foreign tax rate rather than the MNC's home country tax rate (and credit structure) for tax deductibility of interest.

Table 2

Results of Numerical Comparison of
NPV:WACC versus APV Without Interest Subsidy

	$\bar{\pi}$		
	216,000	250,000	200,000
NPV:WACC - I	-200,000	-74,074	-259,259
APV - I	-200,000	-74,074	-259,259
D**	400,000	462,963	370,370

Notice in Table 2 that both methods, NPV using WACC and APV, yield identical results for Booth's numerical example. Both methods require advance knowledge of the optimal debt capacity of the project, D*/V. The dollar amount of debt issued according to either method will be the same, D**. Booth's claim that NPV using WACC must also be known before APV can be calculated is contradicted by equation (2a). To solve (2a) for APV one merely substitutes for D** (=(D*/V)·APV) and solves for APV. This process is a simple arithmetic calculation since (2a) is linear in APV. Indeed, solving for K_e and K_a in (1a) for NPV:WACC is much more tedious.

Now consider the case with an interest subsidy.

<u>With Interest Subsidy</u> (i.e, $K_{d1} \mid K_{d2}$)

$$(1b)\ \text{NPV:WACC} = \frac{\bar{\pi}(1-t_c)}{K_a} \qquad \text{where } K_a = K_e\frac{S^*}{V} + K_{d2}(1-t_c)\frac{D^*}{V}$$

$$\text{and where } K_e = K_o + (1-t_c)(K_o\frac{K_{d2}}{K_{d1}} - K_{d2})\frac{D^*}{S}$$

$$(2b)\ \text{APV} = \frac{\bar{\pi}(1-t_c)}{K_o} + D^{**}t_c + \frac{i_d D^{**}(1-t_c)}{K_{d1}}$$

$$\text{where } D^{**} = \frac{D^*}{V} \cdot \text{APV} \quad \text{and } i_d = K_{d1} - K_{d2}$$

Again using Booth's numerical example as above but now with his additional assumption of $K_{d2} = .1$ reflecting the interest rate subsidy (and thus $\frac{D^*}{V} = .6$ now reflecting Booth's "coverage rate" assumption on debt capacity) we can substitute into (1b) and (2b) to calculate Table 3.

<u>Table 3</u>

Results of Numerical Comparison of
NPV:WACC versus APV With Interest Subsidy

	$\bar{\pi}$		
	216,000	250,000	200,000
NPV:WACC - I	0	157,407	-74,074
APV - I	0	157,407	-74,074
D**	600,000	694,444	555,556

In Table 3 both methods yield identical results as expected. Again D** is the same for both. Booth's different results in his Table 3 occur because he held D** constant at $600,000 in all three APV examples rather than solving[9] (2b) to yield the correct APV and D** (he mentions the correct debt amount on p. 10). It can be shown, on the other hand, that he implicitly lets the level of debt <u>vary</u> to the correct amount in his corresponding three NPV:WACC examples--this simple oversight causes the different results he reports which "prove" APV to be incorrect. Thus,

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[9]Again, APV is the solution to a simple linear equation. Substituting in (2b) for D** yields:

$$APV = \frac{\bar{\pi}(1-t_c)}{K_o} + \frac{D^*}{V} \cdot APV \cdot t_c + \frac{i_d \; D^*(1-t_c)APV}{K_{d1}V}$$

$$APV[1- \frac{D^*}{V}(t_c + \frac{i_d}{K_{d1}}(1-t_c))] = \frac{\bar{\pi}(1-t_c)}{K_o}$$

$$\text{(2b')} \quad APV = \frac{\bar{\pi}(1-t_c)}{K_o} / [1 - \frac{D^*}{V}(t_c + \frac{i_d}{K_{d1}}(1 - t_c))]$$

where $\frac{i_d}{K_{d1}}(1-t_c)$ is the present value (per unit of debt) of the perpetual subsidy adjusted for reduced tax shields. Given Booth's assumption of the Donaldson coverage ratio determination of D*/V, this latter formulation, (2b'), is what Booth should have solved for and presented in his Table 2.

when correctly applied under Booth's assumptions, NPV using WACC and APV yield identical results as Myers' analysis clearly shows. Given D*/V, the calculations for (2b) are <u>less</u> complicated than for (1b) as Booth claims. Further, Booth's formulation of the interest subsidy case is unrealistic. Concessional credit typically is rationed and is granted in relation to some aspect of the project--e.g., initial investment or jobs created--other than its NPV! In such cases, as we show below, VCR is even more appropriate.

In summary, If either conditions I or II above exist, only APV will give the correct result. The formulation is simple and shown in Lessard [6,8] for the international case. Calculations of WACC will be complicated and indeterminate, and only numerical approximations are possible. The resultant errors in NPV are discussed in Myers [10]. The following section of this paper shows how VCR can be used to deal with some of the typical complexities that arise in international capital budgeting situations.

3. <u>ADVANTAGES OF VCR IN INTERNATIONAL PROJECT EVALUATION</u>

The advantages of VCR over WACC go far beyond its more correct and explicit treatment of the tax effects of borrowing. By separating the valuation problem into components, VCR makes it possible to employ different valuation techniques where most appropriate. Some components can be valued directly by analogy to traded securities without resort to explicit cash forecasts and discounting. This is most likely to be the case with debt equivalents such as depreciation tax shields, but may be the case with certain equity and option equivalents as well. For example, the cash flow stream from a producing oil field may be valued on the basis of existing, traded oil participation shares such as those of LASMO (London and Scottish Marine Overseas). Other components are best

valued via the usual method of forecasting expected cash flows and discounting them at an appropriate rate. Still others must be treated as options and, as a result, cannot be properly valued via the usual DCF approach since they involve nonproportional claims on some underlying asset. The finance literature abounds with examples including the option to abandon, the option to expand facilities at some future point, and the option to call on government loan guarantees. Finally, in many analyses the choice will hinge on the future value of a variable that is extremely difficult to forecast. In such cases, VCR makes it possible to structure the analysis to highlight the breakeven value of that variable.

In the case of international projects, these aspects of the VCR approach are particularly appealing. The conditions which cause WACC to fail in the treatment of interest tax shields are the rule rather than the exception. Financing complications such as project-specific concessional finance and stand-alone project financing are commonplace. They are handled readily in a VCR context, but make the WACC approach complex and cumbersome. In fact, when concessional financing is limited in amount, there will be different weighted-average costs for projects that differ only in scale. Political risks, if they are related to project outcomes, should be treated as options. Hence, they cannot be handled appropriately in a standard DCF framework, but present no conceptual problem in VCR. Finally, VCR allows analysis of different components using different numeraires. While this provides no theoretical advantage, it may increase the intuitiveness of the analysis.

In the sections that follow, we illustrate how VCR treats some of these issues. These are: (1) blocked funds, (2) concessional financing, (3) cash flows with differing exposures to nominal or real exchange rate

movements, and (4) political risks that depend on project cash flows. In addition, we illustrate the advantages of VCR in sensitivity analysis.

Blocked Funds. Blocked funds are those whose realizable value is less than their face value due to direct remittance restrictions or indirect restrictions such as taxes payable upon remittance. They can enter into project evaluation in two places. Outlays from a project can be drawn from blocked funds and future inflows may take the form of blocked funds. In either case, these funds should be valued by adjusting the cash flows in question to reflect their opportunity cost to the firm. This cost is their realizable value given all the firm's activities except the project in question. It will depend on the mechanisms available for remittance including new investments yielding remittable profits, transfer pricing, and parallel loans.

Any attempt to adjust for the value of blocked funds by varying discount rates is difficult and prone to error for several reasons. First, unless highly unrealistic cash flow time paths are assumed, no single discount rate will properly capture the effects of funds blockage. Second, since most analyses involve mutually exclusive alternatives that differ in scale or project life, a different adjusted discount rate would have to be applied for each project. In addition, in many cases it is useful to first value blocked funds under conservative "default" assumptions and then calculate the possible incremental value that can be derived by making full use of the firm's internal system to reduce the costs of the remittance restriction in question. This is very difficult in a single cash flow, single discount rate framework, but straightforward with VCR.

A possible objection to VCR in the case of blocked funds is that the existence of barriers to cross-border capital flows will result in market segmentation, calling into question the Value Additivity Principle (VAP) which justifies valuation by components. However, VAP requires only that investors can engage in arbitrage among the various income streams available for distribution by the parent firm after corporate taxes. Thus any restrictions or taxes on cross-border transfers to the parent must be reflected in the income stream components, but will not affect the ability to combine or divide these remittable, net of corporate tax streams for valuation. This ability of VCR to deal transparently (as a separate, additive term) with "blocked funds" is one important advantage over WACC. The possible effects of corporate system-wide remittance mechanisms (e.g., parallel loans) may be shown as well.

The fact that local capital markets are not competitive because of internal controls or lack of the necessary institutional infrastructure, or are isolated from other markets by barriers to cross-border transactions, is irrelevant in the valuation of projects by wholly-owned ventures in such countries by firms based in countries with relatively open, competitive capital markets. These conditions may change the investment opportunity set facing the firm through their impact on the competition for projects resulting from differences in project valuation by local and international firms, but the appropriate context for the valuation of these flows is the base country capital market. Even in the case of joint ventures, these conditions will have no effect on the valuation of a given set of income streams by the international firm,

although they may lead to different valuation criteria for the local firm and hence to lack of agreement between the participants regarding investment and financing decisions.

Concessional Finance. With project-specific concessional finance, the present value of the subsidy can simply be added to the overall project value when VCR is employed. This is especially important in the case of concessional loans or loan guarantees where there is risk of default. In such cases, the "cash-grant equivalent" of the financing depends not only on the stated interest rate but also on the variance of the firm's (local subsdiary's) cash flows. This feature requires the application of contingent claims analysis and would be nearly impossible to model in the WACC framework. As in the case of blocked funds, any attempt to model concessional finance in a single discount rate will be both difficult and prone to error.

VCR Treatment of Cash Flows with Differing Exposures to Nominal and Real Exchange Rate Movements. An individual international project may involve cash flows in several different currencies, some proportion of which will be contractually denominated in those currencies and the remainder of which will be determined by the interactions of future business conditions and changes in relative prices, price levels, and exchange rates. These flows can be viewed from four different perspectives as illustrated in Table 4: either in the base currency or the local currency, and either in current or constant terms. The only critical requirement for correct valuation is that the discount rates used are consistent with the way the cash flows are stated--if current (i.e., nominal) values are used, the discount rates must incorporate the

relevant inflation premiums; if constant (i.e., real), the discount rates should not include inflation premiums.

Table 4

Alternative Cash-Flow Perspectives

	Treatment of Inflation	
Currency	Real	Nominal
Local	I	II
Base	III	IV

Common practice in estimating and evaluating cash flows can be characterized as follows. Firms first project expected revenues and expenses in constant terms, linking present unit costs and revenues with future unit sales projections. These flows are transformed into current terms by inflating them at the anticipated general rate of inflation. If the flows are not already stated in the base currency, they then are translated into current base currency units using projected exchange rates. This process involves moving from quadrant I in Table 3 to quadrant II and then to quadrant IV. Although there is nothing necessarily incorrect with this approach, it is often applied inconsistently, and important interdependencies between inflation and exchange rates and their impacts on operating and contractual cash flows are often overlooked.

A single cash flow, single discount rate approach requires that one of these four conventions be adopted for all cash flows. The VCR method,

in contrast, allows the analyst to keep the different cash flows in their most suitable form. Operating flows can be modelled in real terms, drawing attention to the fact that they will vary from the purchasing power parity base case in line with real changes in exchange rates. Contractual flows such as depreciation tax shields and financing concessions, in contrast, can be left in nominal terms and valued using appropriate nominal market discount rates. This serves to highlight the fact that they are exposed only to movements in nominal exchange rates. It also eliminates the need to estimate currency risk premia since the resulting contractual flows can be valued at nominal market interest rates that already reflect the market's expectations as well as any required premia.

Political Risk. Several authors including Shapiro [18] and Levi [9] have derived explicit formulas for incorporating political risk as an adjustment to the discount rate rather than as an adjustment to expected cash flows. To do so, they have had to assume that the risk in any period of expropriation, conditional on no previous expropriation, follows a highly restrictive time path. Further, they implicitly assume that the likelihood of an expropriation is independent of project cash flows. With VCR, any pattern of risks can be accomodated. Most significantly, risks of takings that depend on project outcomes, such as the risk of contract renegotiation in the case of an extractive project, can be properly modelled as call options held by the government.

VCR and Sensitivity Analysis. A final advantage of VCR over single cash flow, single discount rate approaches is that it lends itself particularly well to sensitivity analysis since all the project's cash

flows need not be replicated or adjusted. Only those specific to the component for which the sensitivity analysis is appropriate require modification. The new present value of that component is then incorporated into the additive stream for the project as a whole. Indeed, simple inspection of the changes in component present value may be all that is necessary. Furthermore, many uncertain outcomes are never reduced to specific cash flows, but instead are dealt with by testing the sensitivity of cash flows to changes in a particular assumption and by judging whether a particular variable is likely to exceed a "break-even" value.

The ability in VCR to separate the various terms greatly facilitates such analyses. In most cases, only the operating cash flow streams will need to be run under a variety of scenarios. Similarly, if there is uncertainty with respect to the appropriate discount rates, most of it will center on the risk premium for the operating cash flows, and thus sensitivity analysis can concentrate on these flows. The distinction between real and nominal flows possible in VCR allows a substantially simplified treatment of inflation and exchange rates as discussed above, but it also serves to highlight the differential impact of these factors on the various cash flows.

4. CONCLUSIONS

The VCR approach provides a generalized framework capable of incorporating most of the special financial considerations that arise in evaluating foreign projects. Its attractiveness vis-a-vis traditional approaches, which attempt to force all these factors into a single

term--the weighted average cost of capital--rests only in part on its conceptual superiority. Much of its attraction lies in its transparency and simplicity of use in many situations. In particular, the ability of VCR to show explicitly the contributions of all component cash flows is a valuable aid in capital budgeting. For international projects, critical aspects such as blocked funds, complex financial and tax factors, multiple currencies, nominal and real cash flow specification, and sensitivity analyses are most easily and directly handled in VCR.

While these considerations clearly favor the VCR approach, they do not call for its use in all situations. Little may be lost in using a single discount rate that is roughly consistent with VCR solutions for small, recurring projects with few or no financing interactions. However, even in this case, the VCR framework provides the proper basis for computing these hurdle rates for decentralized use. Any strategic decision that involves financial complexities, though, should be evaluated in the more complete VCR fashion.

The alleged theoretical shortcomings of VCR relative to WACC do not stand up under careful examination. While many complex issues remain unanswered within the VCR framework, it represents an unambiguous improvement over the more common WACC/NPV approach.

APPENDIX

Glossary of Notation (in the order of appearance in the paper)

NPV	=	Net Present Value
APV	=	Adjusted Net Present Value
VCR	=	Valuation by Components Rule
WACC	=	Weighted Average Cost of Capital
MM	=	Modigliani-Miller
t	=	period
T	=	maturity date of the project
$\overline{CF}$	=	expected after-tax (including depreciation deductions but not interest deductions) operating cash flow
K_a	=	weighted average cost of capital
K_e	=	required rate of return on levered equity
S	=	market value of equity
D	=	market value of debt
H	=	maturity date of the debt
V	=	market value of firm (= S + D)
K_d	=	pretax interest rate on debt
t_c	=	corporate tax rate
K_u	=	all-equity required rate of return
K_{aj}	=	project j weighted average cost of capital
r	=	riskless interest rate
β_j	=	project j unlevered beta coefficient
K_m	=	market required rate of return
K_{d1}	=	K_d, the market interest rate on debt

K_{d2}	=	concessional interest rate on debt
$\bar{\pi}$	=	$\overline{CF}$
K_o	=	K_{ae}
D*	=	optimal debt amount under NPV:WACC
D**	=	optimal debt amount under APV
i_d	=	$K_{d1} - K_{d2}$

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